Office of the Washington State Climatologist

March 2020 Report and Outlook

March 6, 2020 http://www.climate.washington.edu/

February Event Summary

Mean February temperatures were above normal for most of eastern WA, but near-normal to below normal elsewhere in the state. Similarly, precipitation also varied across the state. In general, southeastern WA, northwestern WA, and the western slopes of the Cascades received above normal precipitation while the rest of the state received near-normal to below normal precipitation. Not surprisingly, statewide averaged precipitation ranked as near-normal in the historical record (since 1895), averaging out the spatial anomalies. Statewide average February temperature, on the other hand, falls in the top third of the record due to the warm anomalies in eastern WA.

Figure 1 shows the daily temperatures and precipitation at both Bellingham Airport and Wenatchee, illustrating the difference between these locations. Near-normal temperatures are evident at Bellingham Airport while consistently above normal maximum temperatures are observed at Wenatchee. The precipitation was also quite different, with only a couple days of measurable precipitation at Wenatchee compared to 19 at Bellingham. The Cascade Mountain rain shadow was very prominent over the month of February due to the dominance of westerly flow in association with the storms.

For the locations that received near-normal to above normal precipitation for February, the first half of the month was much wetter than the second half. February 1st was an especially wet day for western WA, as one of the atmospheric rivers that impacted the state at the end of January continued into the beginning on the month. Temperatures were quite mild, with Wenatchee (57°F) and Ephrata (56°F) recording record high maximum temperatures on the 1st.

Another strong atmospheric river (AR) event with widespread impacts occurred from the 4th through the 8th. Heavy rain fell in western WA, with at least 17 western WA rivers reaching flood

In this Issue

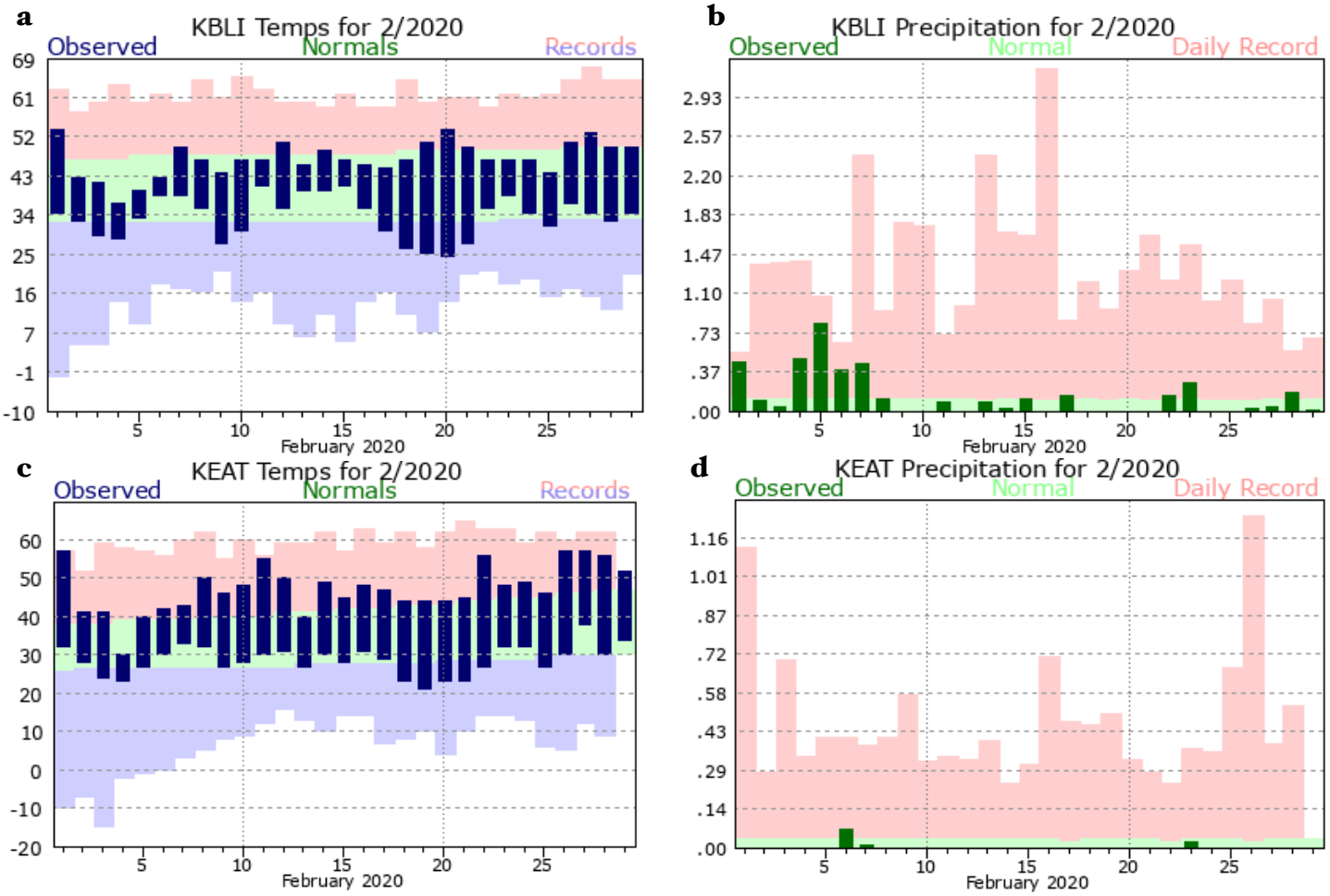


Figure 1: Daily February 2020 (left) maximum and minimum temperatures and (right) precipitation at (a-b) Bellingham Airport and (c-d) Wenatchee compared to normal (green envelope) and records (red and blue bars). NWS

stage. The Seattle Weather Forecasting Office recorded a daily maximum precipitation record of 2.04" on the 5th. Rain from the AR also impacted southeastern WA as well, and Mill Creek in Walla Walla reached record flood stage (Figure 2). Flooding impacts to roads were widespread in southeastern WA; highway 12 through Waitsburg was closed due to flooding from the Touchet River, for example. Governor Inslee issued an emergency proclamation to include 25 counties due to this AR and the heavy rain at the end of January.

The remaining notable weather events for the month relate to the continued warmer than normal temperatures in eastern WA. Ephrata observed a record high maximum temperature (58°F) on the 11th. And, to end the month, Yakima (66°F) and Walla Walla (64°F) recorded spring-like temperatures on the 28th that were daily maximum temperature records.

Figure 2: High flows on Mill Creek at Whitman College (photo by Thomas Reese and published by Northwest Public Broadcasting).

Snowpack and Drought Monitor Update

Mountain snowpack continued to improve during February, despite some parts of the state being drier than normal. The basin average snow water equivalent (SWE) percent of normal as of March 3 from the Natural Resources Conservation Service is shown in Figure 3. All of our basin averages are showing near-normal to above normal SWE, which is an improvement for most of the basins since the beginning of February. The one caveat to keep in mind is that these basin averages are skewed towards higher elevation conditions since that is where the observing sites are located; in reality, there are some lower elevation locations, particularly in eastern WA, with below normal SWE. We will continue to monitor these locations for the remainder of the winter.

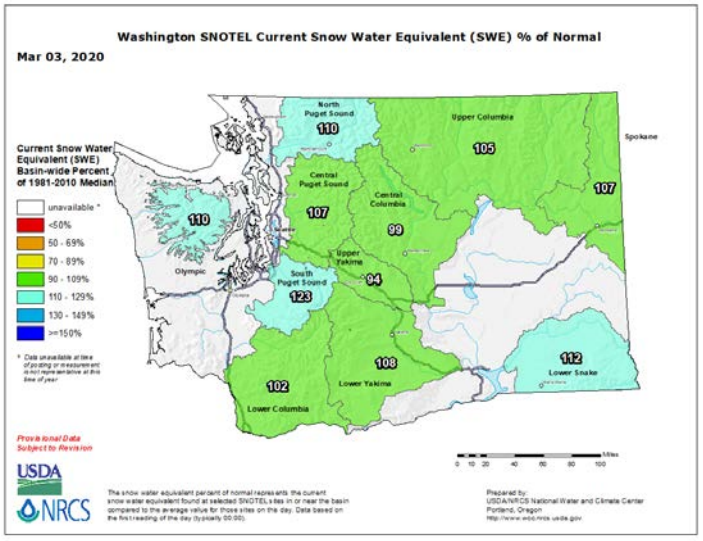


Figure 3: Snowpack (in terms of snow water equivalent) percent of normal for Washington as of 3 March 2020 (from NRCS).

The latest U.S. Drought Monitor (Figure 4) continues to show drought-free conditions in western WA, and has also shown some improvement in eastern WA. Southeastern WA, which experienced heavy precipitation and flooding in early February, has had the greatest improvement (in both the "abnormally dry" and "moderate drought" categories) since our last newsletter.

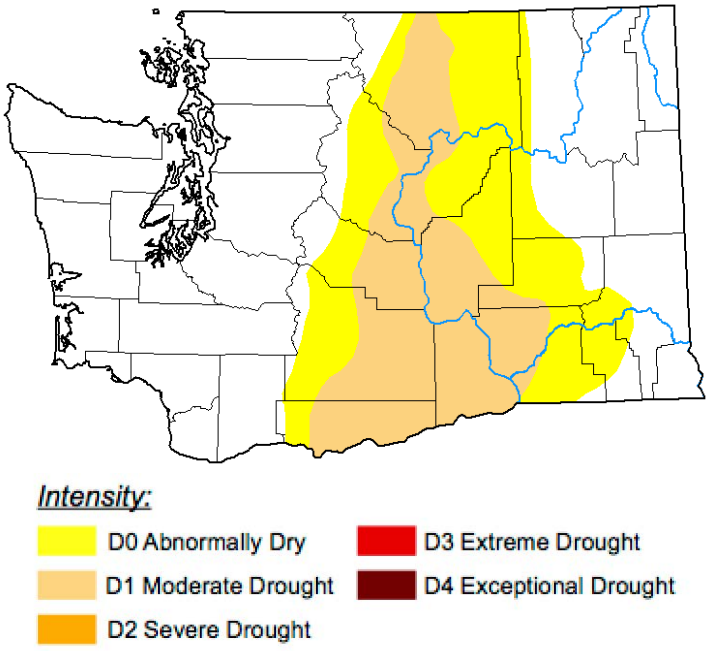


Figure 4: The 5 March 2020 edition of the U.S. Drought Monitor.

3 and 4-week 500 hPa Geopotential Height Predictions for WA

A message from the State Climatologist

As presented previously in this newsletter, filling the gap between deterministic weather forecasts out about 10 days and probabilistic predictions on seasonal (multi-month) time scales is an active area of research for the meteorological community. Information on these time scales is useful, of course, for a range of health, infrastructure, and natural resource managers, among others. OWSC considers 3-4 week forecast information in our briefings to the state's Water Supply Availability Committee (WSAC), for example, to try to anticipate general weather patterns on the horizon. Specifically, since the summer of 2016, we have been presenting 500 hPa geopotential height (Z) anomaly maps for week-3 and week-4 from NOAA's CFSv2 seasonal climate prediction model as a part of these briefings.

But are the forecasts any good? Previous research (e.g., Weber and Mass 2019) has considered this question, and reveals that a proper account of tropical convection is crucial. Given the CFSv2 model's struggles in handling tropical convection, we thought it might be interesting to carry out a quick, semi-quantitative look at the quality of the operational product for WA.

This analysis is far from definitive, as we based our results on the CFSv2 maps presented during 19 past meetings of the WSAC. This totals 38 500-hPa Z forecasts (19 week-3 and 19 week-4); the forecasts represent ensemble means from 16 model runs from an initial data (available: https://origin.cpc.ncep.noaa.gov/products/people/mchen/CFSv2FCST/weekly/). For this mini-analysis, we binned the 500-hPa Z mean anomalies over WA state into 3 categories: below normal, near-normal, and above normal. We repeated that process for both the implied 500 hPa zonal wind (U) and 500 hPa meridional wind (V). For the mean Z, U, and V, we counted up the hits, 1-category errors, and bad misses (2-category errors) in our admittedly small sample of CFSv2 forecasts, using weekly averages from the NCEP Reanalysis as verification. Using Z as an example, a "hit" is one in which the category of the forecasted anomalies matches the verification. A 1-category error is when the direction of the forecast is off by 1 category; for example, a near-normal forecast turns out to have negative heights in reality or a positive height anomaly forecast is actually near-normal. A 2-category error (i.e., a "bad miss") is just as it sounds: a positive height anomaly forecast is actually negative in reality and vice versa.

Figure 5 shows an example of a relatively good forecast from earlier this year (22 Jan 2020). The forecast for the northern hemisphere as a whole is quite similar to the verification in this example; there were others that are comparable or even better in terms of their predictions for the Pacific Northwest. On the other hand, Figure 6 shows an example of a "bad miss" forecast. The forecast made on 31 Jan 2018 for the latter part of February 2018 in this example shows how a CFSv2 forecast can bear little relation to what actually occurs on the 3-4 week time horizon.

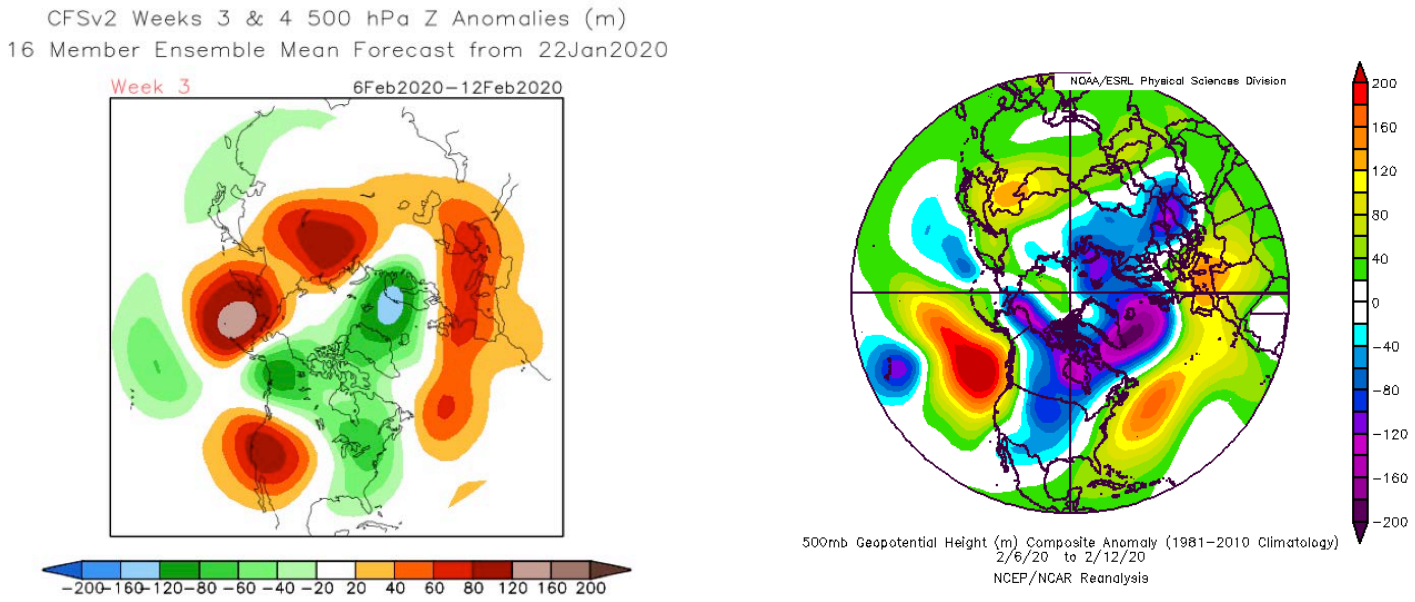


Figure 5: An example of the CFSv2 forecast initialized on 22 January 2020 for 6-12 February (left) and the verification (from ESRL; right) that was a "hit". The week-4 forecast from this same initialization also verified (not shown).

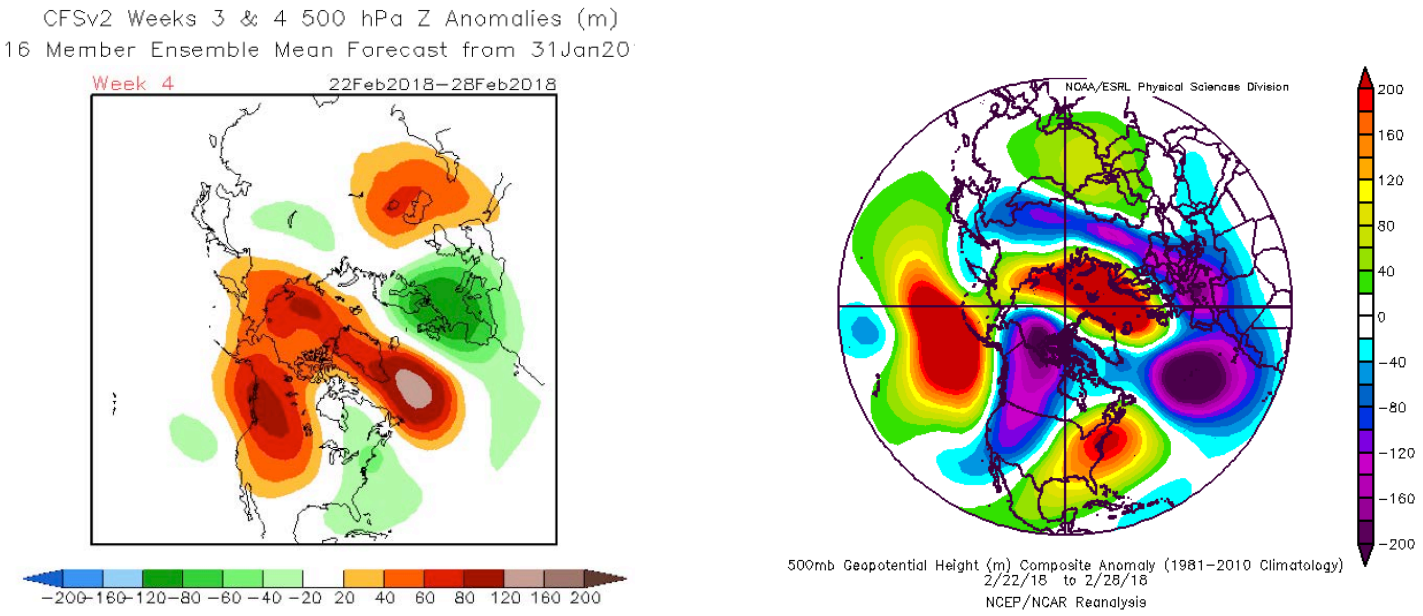


Figure 6: An example of the CFSv2 forecast initialized on 31 January 2018 for 22-28 February (left) and the verification (from ESRL; right) that was a "bad miss".

The summarized results for each of the 38 cases are shown in Table 1. As shown, there are just a few more "hits" than would be expected by chance, assuming each of the 3 categories is equally likely. In terms of 1-category errors, there was almost exactly the number that would be expected if the verifications were picked at random. The better news for forecast accuracy is that there were fewer 2-category errors than by chance, especially with regards to 500 hPa U wind anomalies. We did not formally separate out warm season from cool season anomalies due to the small sample size but our qualitative impression is that there is not that much difference.

We have not considered whether the strongest anomaly forecasts verify any differently, and that would be difficult to conclude with such a small sample size. What might be more meaningful for verifying these forecasts would be to consider the consistency of the CFSv2 forecasts – are they changing from day-to-day and hence is it presumably a less predictable period or does a particular daily forecast closely resemble those for the past few days? If there is daily consistency in the 3-4 week forecasts than it's conceivable that those forecasts are more reliable. That sort of analysis is beyond the scope of the present treatment, however. The take home message from this analysis is that category 2 errors are rare, but we can expect most of the forecasts presented at the WSAC to be either hits or off by one category. In other words, we will continue to look and consider this CFSv2 product, but we are not betting the farm on it!

References

Weber, N.J., and C.F. Mass (2019): Subseasonal weather prediction in a global convection-permitting model. Bull. Amer. Meteor. Soc., 100, 1079-1089, doi:10.1175/BAMS-D-18-0210.1

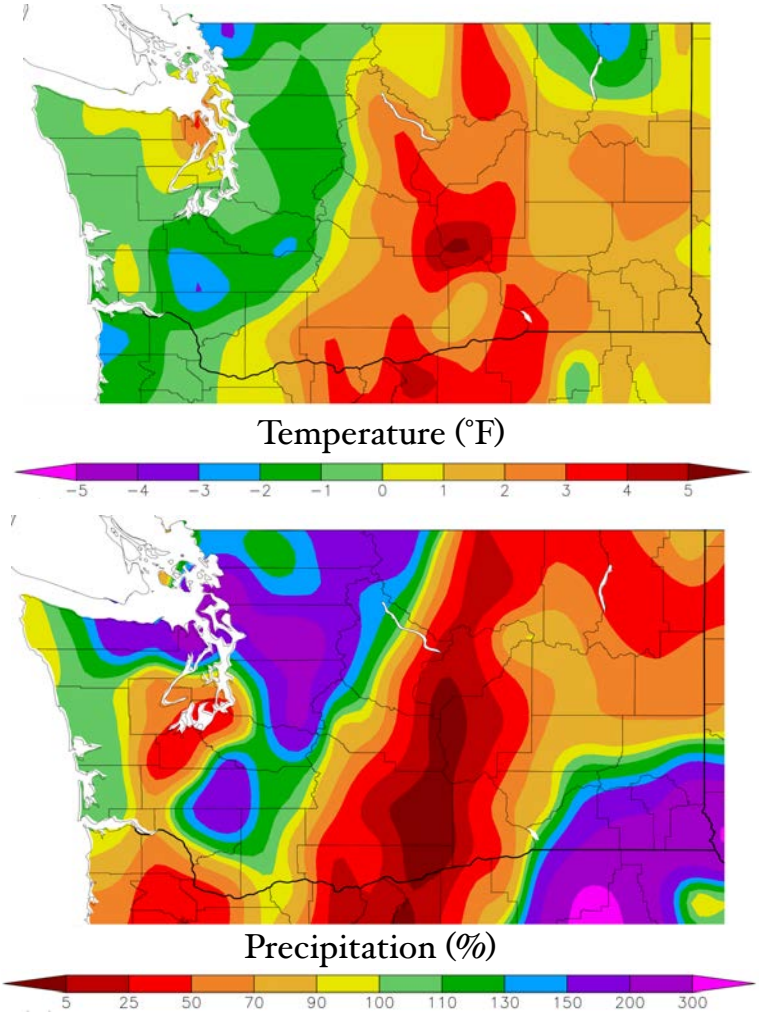
Category	Forecast	Verification	Z	U	V
Hits					
	Normal	Normal	6	5	8
	Either Positive or Negative	Direction Verified	10	9	6
	Total: 44 vs. 38 by chance				
Category 1 Errors					
	Normal	Positive or Negative	8	10	12
	Either Positive or Negative	Normal	5	12	5
	Total: 52 vs. 51 by chance				
Category 2 Errors					
	Either Positive or Negative	Opposite Direction	9	2	7
	Total: 18 vs. 25 by chance				

Table 1: The forecast hits, category 1 errors, and category 2 errors tabulated for the CFSv2 geopotential heights (Z), implied zonal wind (U), and implied meridional wind (V) forecasts compared to NCEP/NCAR Reanalysis verification.

Climate Summary

Mean February temperatures featured a stark split along the Cascades with above average temperatures for eastern Washington, and near-normal to slightly below average temperatures for western Washington, according to the High Plains Regional Climate Center departure from average temperature map. Warm temperature anomalies were centered around the Columbia River basin in which Hanford and Pasco saw temperature anomalies of 2.9 and 3.1 °F above normal, respectively (Table 2). Northern reaches of eastern Washington featured close to and slightly below normal temperature anomalies outside of the Okanogan Valley where Omak recorded average temperatures 3.8 °F higher than normal: the highest temperature anomaly for sites monitored in the newsletter. West of the Cascades, average temperatures sat close to and slightly below normal February temperatures. A local minimum anomaly was seen in SW Washington of -2 to -3 °F, but most other areas of western Washington were near-normal but on the cooler side. Northwestern WA saw a local minimum and maximum; both of which should taken with a grain of salt as both bull's eyes are based on a single station anomaly.

Total February precipitation fell into a similar breakdown as mean temperatures, where the Cascades served as boundary between mostly above average precipitation totals for the west and mostly below precipitation totals for the east. Along the Columbia River Basin east of the Cascades, precipitation totals amounted to only 5% of normal. Close by stations such as Wenatchee and Hanford saw 12% and 13% of normal precipitation, respectively. Not all of eastern WA featured below average rainfall, however. The Blue Mountains in SE Washington observed over 200% of normal precipitation mostly from an atmospheric river early in the month. Northwest Washington also featured above average precipitation as most of Snohomish, Whatcom, Clallam, and King County received over 200% of normal precipitation. While the north and central Sound were above average, the south Sound received below normal precipitation with Olympia seeing only 64% of normal. The coast was unique compared to the rest of the state, receiving near normal precipitation totals: Quillayute and Hoquiam saw 96% and 99% of their expected precipitation totals during February.



February temperature (°F) departure from normal (top) and precipitation percent of normal (bottom). (High Plains Regional Climate Center; relative to the 1981-2010 normal).

	Mean Temperature (°F)			Precipitation (inches)			Snowfall (inches)		
	Avg	Norm	Departure from Normal	Total	Norm	% of Norm	Total	Norm	% of Norm
Western Washington									
Olympia	40.6	41.0	-0.4	3.38	5.27	64	M	4.7	-
Seattle WFO	43.6	43.4	0.2	5.01	3.31	151	0	0.6	0
SeaTac AP	43.6	43.4	0.2	4.05	3.63	112	T	1.7	0
Quillayute	41.4	42.1	-0.7	9.91	10.35	96	M	2.6	-
Hoquiam	42.9	43.7	-0.8	7.14	7.21	99	0	0.8	0
Bellingham AP	40.6	40.8	-0.2	3.94	3.02	131	M	2.4	-
Vancouver AP	43.0	43.5	-0.5	1.60	4.03	40	M	M	-
Eastern Washington									
Spokane AP	35.1	33.0	2.1	0.89	1.33	67	3.8	6.8	56
Wenatchee	37.9	34.8	3.1	0.10	0.81	12	M	4.4	-
Omak	35.6	31.8	3.8	0.24	1.41	17	M	M	-
Pullman AP	35.9	34.9	1.0	2.94	1.52	193	M	M	-
Ephrata	37.0	34.1	2.9	0.14	0.74	19	M	3.1	-
Pasco AP	42.0	38.9	3.1	0.32	0.86	37	M	M	-
Hanford	41.1	38.2	2.9	0.09	0.70	13	0	2.3	0

Table 2: February 2020 climate summaries for locations around Washington with a climate normal baseline of 1981-2010. Note that the Vancouver Pearson Airport and Seattle WFO 1981-2010 normals involved using surrounding stations in estimating the normal, as records for these station began in 1998 and 1986, respectively.

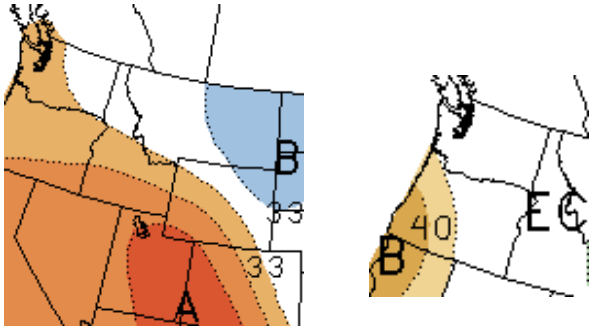
Climate Outlook

According to the Climate Prediction Center (CPC), neutral El Niño-Southern Oscillation (ENSO) conditions are present in the equatorial Pacific Ocean. Sea surface temperatures (SSTs) are slightly above normal for most of the equatorial Pacific with some cooler warm SST anomalies in the eastern quarter. Since the last newsletter, there has been cooling in the central equatorial Pacific and warming in the eastern equatorial Pacific. ENSO models show a continuation of neutral conditions; for March-April-May, there is a 61% chance for neutral conditions to continue. Overall, ENSO is not liable to be a big player in our climate over the next few months.

The CPC March outlook predicts slightly elevated chances of below normal temperatures for the western two thirds of the state. As for the eastern third of the state, there are equal chances for above, near-normal, or below normal temperatures. The precipitation outlook gives equal odds of above, near-normal, or below normal precipitation for the entire state, giving little indication of how the month's precipitation will turn out.

The CPC March-April-May (MAM) seasonal temperature outlook gives a slightly increased chance of above normal temperatures for western Washington and areas nestled west of the Columbia River and south of I-90. The NE corner of state sees equal chances of above, near-normal, or below normal temperatures. The spring precipitation seasonal outlook is also uncertain, with equal chances of above, near-normal, or below normal precipitation across the entire state.

March outlook for temperature (left) and precipitation (right)



March-April- May outlook for temperature (left) and precipitation (right)

(Climate Prediction Center)